GEOINFORMATION AS AN AID TO THE RESPONSE OF THE EMERGENCY SERVICES AT INDUSTRIAL PARK

Juan Luis Martín Romero [a], Tomás Ramón Herrero Tejedor [a], Enrique Perez-Martin [a], Juan López de Herrera [a], Alejandra Ezquerra Canalejo [b]

[a] Technical University of Madrid (UPM), Department of Agroforestry Engineering, Ciudad Universitaria, 28040 Madrid, Spain.
[b] Technical University of Madrid (UPM), Department of Engineering and Forestry and Environmental Management, Ciudad Universitaria, 28040 Madrid, Spain.

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Corresponding author:
J.L. Martín Romero
Tel.: 913363707
Fax.: 913365406
e-mail: juanluis.martinr@upm.es
Address: E.U.I.T.Agrícola. Ciudad Universitaria. Madrid

Abstract

The defense against risks that can affect the industrial buildings is one object of study in the field of civil protection at the municipal level.

Increasingly more administrations and users themselves arouse us that the same citizen which must acquire proper training to deal with any problems that arise in the field of security. Today may be timely use of information systems as an aid to emergency systems that are intended to provide service to society.

The study aims to facilitate the work of those responsible for civil protection through the optimal use of geo-information to shorten response times.

The area used for this study corresponds to an industrial park in the town of Paracuellos del Jarama (Madrid). Maps and images from different sources of information have been used. A database related to inherent risks within the companies that develop their activity within the tested polygon was subsequently designed.

We have created an information system that improves the response of emergency civil protection services by risks in industrial park.

1 Introduction

Risk assessment methods are applying for several decades, legislative obligation, both for technical reasons in order to assist security professionals in decision-making [1]. Currently, due to the technological advances in the field of the technical coordination and simulation applied [2] in a new method in Building Information Modeling (BIM) building, risk assessment methods allow model, simulate, and implement solutions to deal with the risk of fire and its spread [3]. There are different methods of evaluation of the fire risk that quantify the level of risk of the establishment and provide different protection measures to be carried out [4]. The Article 20 of the 31/1995 law of Prevention of Occupational Risks [5] set the employer must analyze possible emergency situations and take appropriate measures in the field of first aid, the fire-fighting and evacuation of workers. In the case of industrial establishments, the assessment of the risk of fire is regulated by the RD2267/2004, of 3 December, which approves the regulation of Fire Safety in Industrial Establishments [6].

When designing a plan of self-protection must pay special interest in the choice of the method of evaluation of the risk of fire. This will determine in the majority of cases the success of the analysis to be carried out. There are several methods that exist for the evaluation of the risk [6]. MESERI method, compared to others, is the most simple method and the most widely used by analysts of risks [7]. MESERI method is an initial orientation that will serve only for a quick view of the overall risk of fire in the chosen place.

On the one hand the method uses a series of factors which cause or exacerbate the risk of fire, such as installations, and other factors, factors that collaborate with the protection against the risk of fire.

Thus in the numerical value of the risk function, we obtain by using a table the risk rating. The objective of the study is to develop a map of risks of the industrial estate "El Cerbellon" to control or eliminate the most relevant risks of the various companies and the subsequent conclusions, recommendations and action plans.

Analysis of the risk of fire in an industrial area implies the fulfillment of three main stages,

- Physical inspection of the site of the potential risk
- Evaluation of the magnitude of the irrigation
- Report and response measures

Evaluates the probability of the risk occurring and the intensity and vulnerability in the event of occurrence of the same. MESERI method uses the point scheme. It is based on the individual consideration of various generators and aggravating factors and risk of fire (X) and also independently of them that reduce and protect against risk (Y). Once obtained the X and Y factors, apply the equation 1,

$$P = \frac{5X}{129} + \frac{5Y}{26} + B \qquad (1)$$

Where P is the value of the risk result. Coefficient B is the coefficient found in 2.2b and evaluates the existence of a brigade internal fire.

The method allows an overall appraisal of the risk of fire and is mainly designed for application in small and medium-sized industrial type whose activity is not inherently dangerous. A visual inspection of a number of factors of a building and its comparison with a few preset values will give us the information resources for the estimation of risk P which will be between the values 0 and 10.

Industries whose score is less than 5 should be evaluated in more detail, investigating in the first place the scored zero. On the other hand, nor it should be understood that the score greater than 5 indicates that there is no risk of fire.

2 Methodology

The zone of study (fig. 1) is located in the Industrial Park of "El Cerbellon", belonging to the municipality of Paracuellos del Jarama (Madrid).

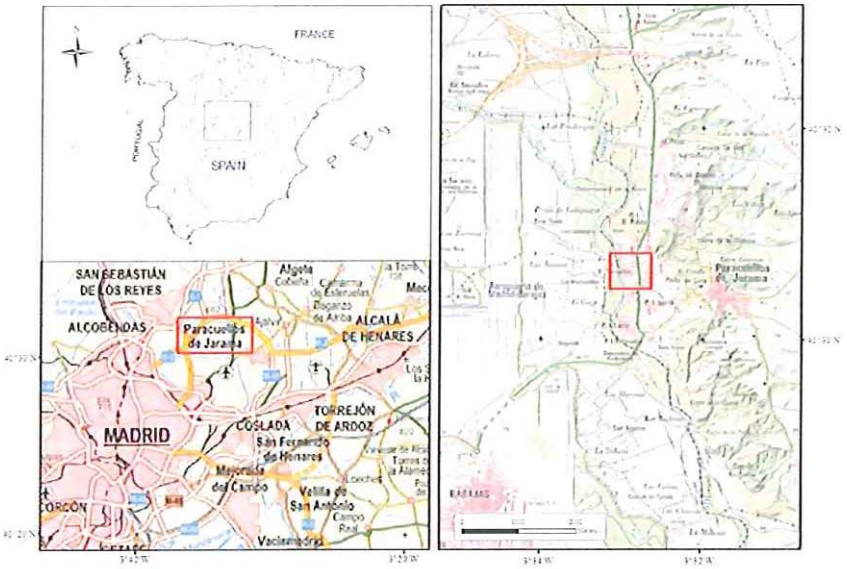

Fig. 1. Location of the industrial park used in the methodology. The industrial park "Cerbellón" is located to the West of the town of Paracuellos del Jarama, very close to the airport "(Adolfo Suarez-Madrid Barajas)." Spatial Reference System UTM ETRS89 Zone 30N

It is obvious that a simplified method must bring together lots of information in a small space, having been necessary to select only the most important aspects and not consider other less relevant. Each of the risk factors is subdivided in turn take account of the most important aspects to consider, as we will see below.

Applies a coefficient depending on which lead to the risk of fire or don't do it, from scratch in the worst case up to ten in the most favorable case. It includes two blocks of different factors:

2.1 Generators and aggravating Factor and risk (X)

a) Construction

- Building height. Height of a building means the difference in dimensions between ground floor or basement last floor and the slab which is the cover. Between the coefficient corresponding to the number of floors and the height of the building, the child will take.

Number of floors	Height	Coefficient
1 or 2	Minor than 6 m	3
3, 4 or 5	between 6 and 12 m	2
6, 7, 8 or 9	between 15 and 20 m	1
10 or more	more than 30 m	0

Table 1. Valuation according to the warehouse height.

If the building has different heights and the highest part occupies is more than 25% of the surface in the whole plant, the coefficient will be taken at this point. If it is less than 25% it will be taken the coefficient of the building.

- Largest sector of fire. It means sector of fire for the purpose of this method, the area of the building bounded by fire-resistant elements 120 minutes. In the case that is an isolated building will take its total area, although closures have lower resistance.
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Largest sector of fire	Coefficient
Minor than 500 m²	5
From 501 to 1.500 m²	4
From 1.501 to 2.500 m²	3
From 2.501 to 3.500 m²	2
From 3.501 to 4.500 m²	1
More than 4.500 m²	0

Table 2. Valuation according to extension

- Fire resistance. It refers to the structure of the building. He understands how resistant to fire, a concrete structure. A steel structure will be considered as non-combustible and, finally, fuel if it is different from the previous two. If the structure is mixed, a ratio intermediate between the two dice will be taken.
- Suspended ceilings. He is understood as such to the coatings of the upper part of the structure, especially in industrial buildings, placed such as thermal, acoustic insulation and decoration.

Fire resistance	Coefficient
Fire resistant	10
Noncombustible	5
Combustible	0

Suspended ceilings	Coefficient
Without suspended ceilings	5
Fireproof suspended ceilings.	3
Combustible suspended ceilings	0

Table 3. Valuation according to resistance to fire and suspended ceiling.

b) **Situation.** They are those who depend on the location of the building. Two are:

- Distance from the fire service. Be taken, preferably, the coefficient corresponding to the response time for firefighters, using the distance to the Headquarters only orientative.

Distance	Time	Coefficient
Less than 5 km	5 minutes	10
Between 5 and 10 km	from 5 to 10 minutes	8
Between 10 and 15 km	from 10 to 15 minutes	6
Between 15 and 25 km	from 15 to 25 minutes	2
More than 25 km	more than 25 minutes	0

Table 4. Assessment by distance to firefighter service.

- Accessibility of the building. Shall be classified in accordance with the width path, provided that it meets one of the other two conditions of the same rank or higher. If not, will be lowered to the less immediate coefficient.

Wide path	Accessible facades	Distance between doors	Qualification	Coefficient
More than 4 m	3	Less than 25 m	GOOD	5
Between 4 y 2 m	2	Less than 25 m	MEDIUN	3
Less than 2 m	1	More than 25 m	BAD	1
There is no	0	More than 25 m	VERY BAD	0

Table 5. Valuation according to the accessibility of the building.

c) **Processes and/or destinations**. The characteristics of manufacturing processes that are made, the products used and the destination of the building should be collected.

- Danger of activation. You try to pick up the possibility of starting a fire. We must mainly consider the human factor which, by recklessness can activate the burning of some products. Other factors are related to the energy sources present in the analyzed risk.

  - Electrical: transformers, distribution of energy, maintenance of facilities, proper protection and design.
  - Steam and hot water boilers: fuel distribution and maintenance of burners.
  - Hazardous specifics: operations open flame, such as welding, and sections with presence of combustible powder.

Danger of activation	Coefficient
Low	10
Medium	5
High	0

Table 6. Assessment of the manufacturing process.

- Fire load. Means as weight in wood surface (kg/m²) unit capable of developing an amount of heat equivalent to the materials contained in the fire sector.

Fire load		Coefficient
Low	Q < 100	10
Medium	100 < Q < 200	5
High	Q > 200	0

Table 7. Valuation according to fire load.

- Combustibility. The ease with which materials react in a fire shall be deemed as combustibility. If there is a qualification by testing is used this as guide, otherwise, the technical evaluation criteria should be applied.
- Order and cleanliness. The criterion for the application of this coefficient is purely subjective. Means high when they exist and are respected areas delimited for storage, the products are properly stacked in place, there is no dirt or debris or cuts throughout the ship indiscriminately.

Combustibility	Coefficient
Low	5
Medium	3
High	0

Order and cleanliness	Coefficient
Low	0
Medium	5
High	10

Table 8. Valuation according to combustibility and order and cleanliness.

- Storage in height. Become a simplification in the factor of storage, whereas only the height, by understanding that a poor distribution in surface can be assumed as lack of order in the previous section.

Storage in height	Coefficient
h < 2m	3
2 < h < 4m	2
h > 6 m	0

Table 9. Valuation according to storage height.

d) **Concentration factor.** Represents the value in $/m² of the contents of installations or sectors to evaluate. It is necessary to note that protections must be higher in case of important concentrations of capital.

Concentration factor	Coefficient
Less than 1000 $/m²	3
Between 1000 y 2500 $/m²	2
More than 2500 $/m²	0

Table 10. Valuation according to concentration factor.

e) **Propagability (ability to spread).** Facility means as such to spread the fire, within the sector of fire. It is necessary to take into account the provision of products and stocks, storage shape and clearances from combustible products.

- Vertical. It will reflect the possible transmission of fire between floors, taking into account an adequate separation and distribution.
- Horizontal. You will be assessed the horizontal spread of the fire, also attending the quality and distribution of the materials.

Vertical spread	Horizontal spread	Coefficient
Low	Low	5
Medium	Medium	3
High	High	0

Table 11. Valuation according to fire propagation.

f) **Destruction.** The influence of the effects produced in a fire, on the materials, elements and existing machines will be studied. If the effect is frankly negative applies the minimum ratio. If does not affect the content, then will apply high.

- Heat. It will reflect the influence of the temperature rise in machinery and existing elements. This coefficient will hardly be 10, since heat usually affects the content of the analyzed sectors.
  - Low: when stocks are not destroyed by heat and not there is precision machinery or other items that could damage by the action of heat.
  - Medium: when stocks would degrade heat without destroying it and machinery is scarce.
  - High: when products are destroyed by the heat.
- Smoke. The damage will be studied by smoke to machinery and materials or existing elements.
  - Low: when the smoke affects little products, well because not expected its production, well because the subsequent recovery will be easy.
  - Medium: when the smoke affects the products partially or expected little formation of smoke.
  - High: when the smoke completely destroys products.
- Corrosion. It takes into account the destruction of the building, machinery and stocks as a result of oxidizing gases detached in the combustion. A product that must particularly be taken into account is the hydrochloric acid produced in the decomposition of the polyvinyl chloride (PVC).
  - Low: when not expected the formation of corrosive gases or products not are destroyed by corrosion.
  - Medium: when he is expected the formation of oxidizing gases which affect stocks nor in form important building.
  - High: when expected the formation of oxidizing gases that affect the building and machinery significantly.
- Water. It is important to consider the destruction by water since it will be the key element to get the fire.
  - High: when products and machineries are destroyed completely by water effect.
  - Medium: when some products or stocks suffer irreparable damage and others are not.
  - Low: when the water does not affect products.

By heat	By smoke	By corrosion	By water	Coefficient
Low	Low	Low	Low	10
Medium	Medium	Medium	Medium	5
High	High	High	High	0

Table 12. Valuation according to destruction by heat, smoke, corrosion and water.

2.2 *Protection factors*

a) Facilities

The existence of adequate protection is considered essential in this evaluation method for the classification of the risk. So much so that, with full protection, the qualification will never be less than 5. Naturally, a simplified method that intends big agility should reduce the range of fire protection measures to the indispensable minimum, by what they consider only the most common.

We have also considered the existence of media such as the protection of dangerous points with special fixtures, fixed systems of gaseous agents and the availability of fire brigades.

Factors of protection facilities	Without surveillance	With surveillance
Hand extinguishers	1	2
Fire hydrants	2	4
External hydrants	2	4
Fire detectors	0	4
Automatic sprinkler	5	8
Fixed installations	2	4

Table 13. Valuation according to means of protection.

b) **Internal fire brigades**. When analyzed the building or plant has personnel specially trained to act in the case of fire, with the equipment needed for its function and appropriate personal protection elements, the coefficient associated B adopt values:

Internal fire brigades	Coefficient
If there is a brigade	1
If there is no brigade	0

Table 14. Valuation according to existence of personal fire.

2.3 *Method of calculation.*

To facilitate the determination of the coefficients and the evaluation process, the required data have ordered in a form which, after completion, carries the following numerical calculation:

Subtotal X: sum of the coefficients corresponding to the first 18 factors.

Subtotal Y: sum of coefficients corresponding to the existing means of protection.

Coefficient B is the coefficient found in 2.2b and evaluates the existence of a brigade internal fire.

The coefficient of protection against fire (P) shall be calculated by eq. 1

The value of P offers numerical evaluation method, so that object:

For a qualitative evaluation:

P-value	Category
0 a 2	Very serious risk
2,1 a 4	Serious risk
4,1 a 6	Medium risk
6,1 a 8	Slight risk
8,1 a 10	Very slight risk

Table 15. Qualitative evaluation of the P index.

For an exhaustive assessment:

Acceptability	P-value
Acceptable risk	$P > 5$
Not acceptable risk	$P \leq 5$

Table 16. Limited evaluation of the risk of fire.

When you have chosen the method of evaluation of the risk of fire (MESERI) we made the field work consisting first the on-site data collection. Therefore is fill out a form, previously designed for this purpose, which includes all the features of the company to be evaluated. There were also photographs of buildings that are subsequently included in the tab.

The next step is the study of all the variables, as well as the display of the photographic archive to reach the objective assessment of the risk "P" of each building individually.

The information produced from data of field and subsequent process of preparing industrial building has been treated by a data information system to perform the geo-visualization in the industrial area.

Risk is weighted between values from 0 to 10, constituting the value 0 to the buildings most susceptible to damage and 10 buildings more protected.

3 Results

The enclosed (Fig. 2) is the result of the field work put it in an Excel sheet designed for this purpose. The introduction of values evaluated in the sensory perception of the industrial buildings makes it possible to through the application of method of Meseri obtain rapidly the value of risk data.

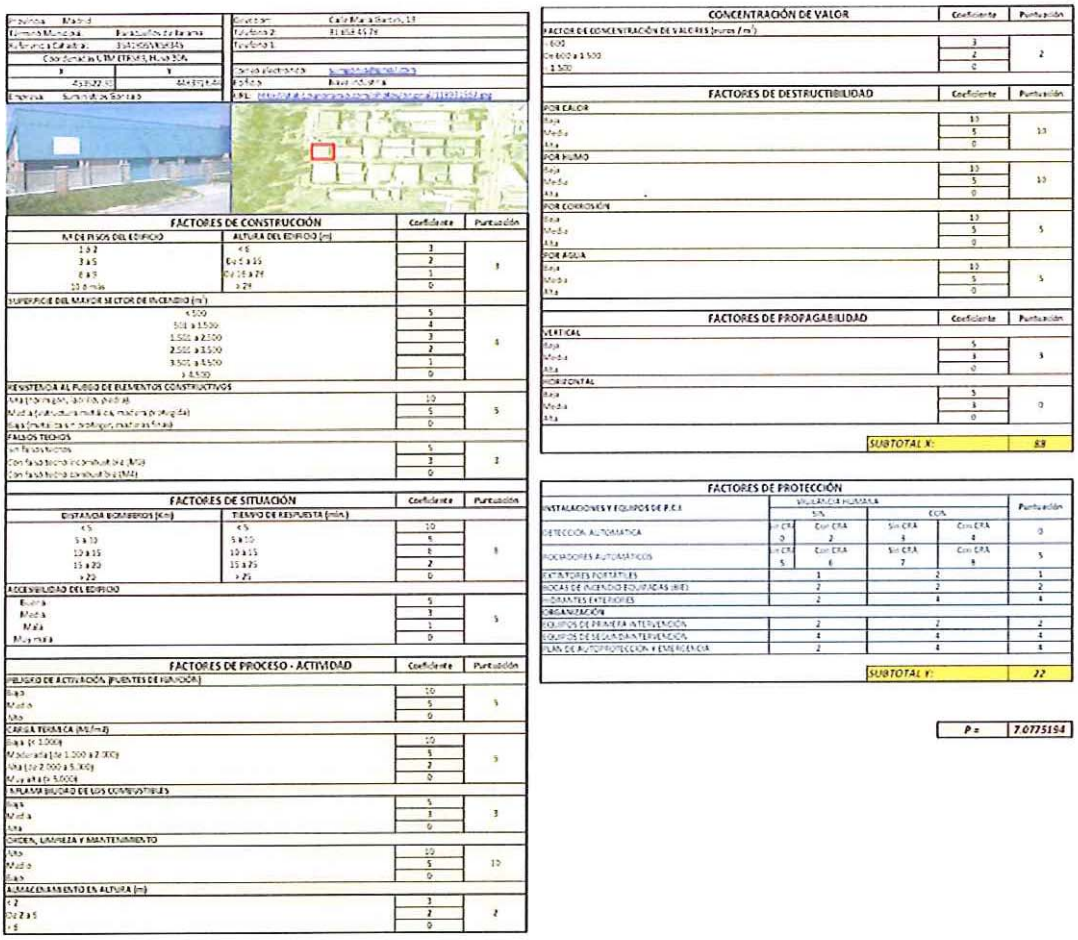

Figure 2. Example of tab of industrial ship for the study of assessment of risk by fire by Meseri method.

This work provides a chromatic contribution study, which, together with the application GIS location becomes a visual approach of the problem (Fig. 3).

The Fire extinguishing media and Civil Protection and Security can check in real time and even before that the focus of the fire from reaching the characteristics of the environment. They make as well a decision what is the area with big risk or you need greater protection once the fire started, either by the constructive characteristics, by measures of self-protection that contemplate, or even by the accessibility of these media to other buildings within the industrial estate that study.

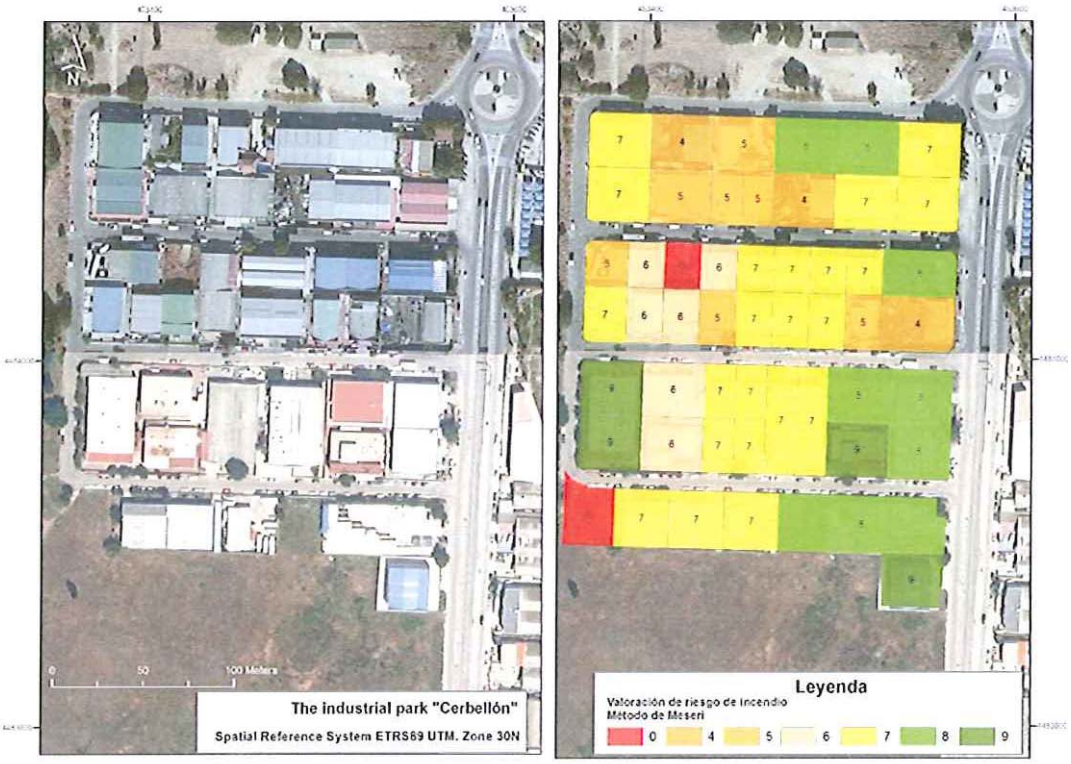

Figure 3. Analysis of the study of risk of fire from Meserí method. Location in

Spatial Reference System UTM ETRS89 Zone 30N.

4 Conclusion

La utilización del método MESERI, frente a otros, es la sencillez y rapidez para la evaluación de incendios. Resultando un método casi intuitivo para personas con experiencia en evaluación de incendios. Otros riesgos pueden aportar más información pero su complejidad en el cálculo nos lleva a desestimarlos.

The choice of method MESERI, compared to others, is the simplicity and speed for the fire risk evaluation. Resulting in a very intuitive method for people with experience in fire risk evaluation. Other risk evaluation methods can provide more information, but its complexity in the calculation leads us to reject them.

The Fire extinguishing media, Civil Protection and Security, will have an application which before leaving their bases could have a rational vision and objective of the environment and thus devise a strategy of attacking the problem.

Based on this study, we could develop one action that is to provide signals on the facades of the buildings according to the rate of fire hazard valued by the method developed, embodied in different colors according to the same.

In terms of prevention, provides a reasoning right by which companies that have proven a rate very low (red) must organize his own work guides consistent to converge towards green tones.

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